Workshop on In-Space Fabrication and Repair

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Vision and Mission:
Our New Starting Point

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OBPR

Office of Biological & Physical Research

Strategic Organization
A Whole New Approach

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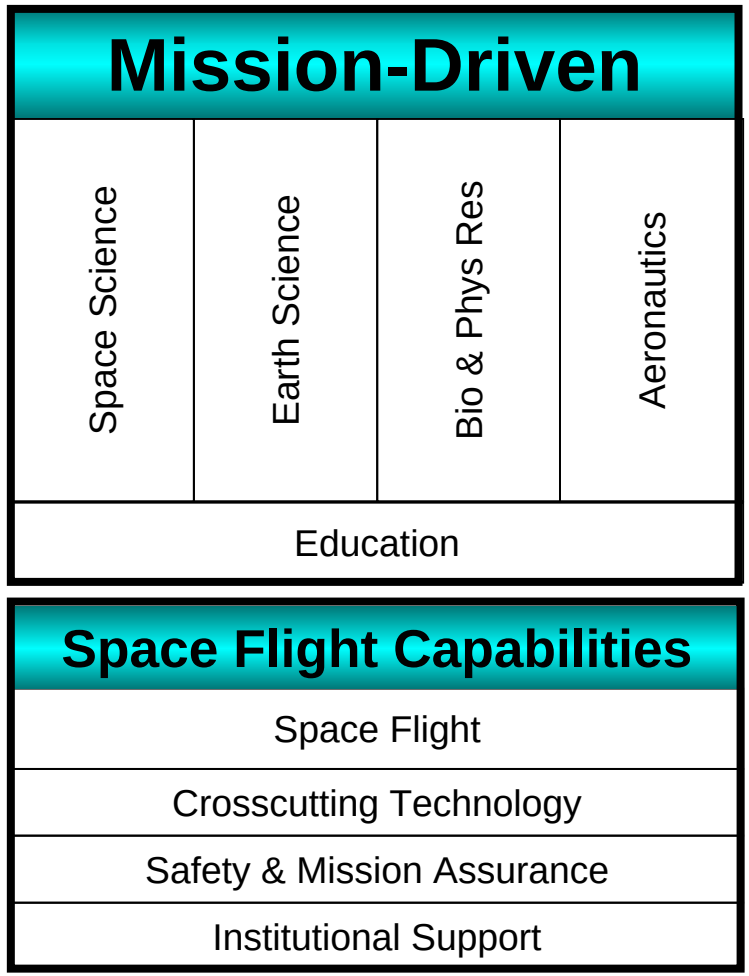
PREVIOUS

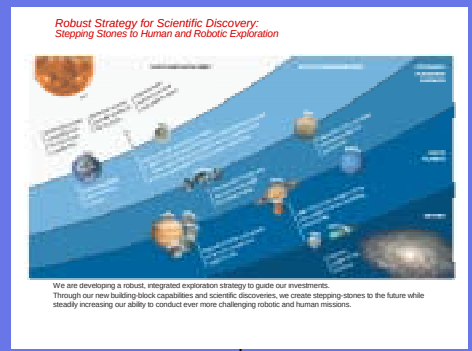
NEW



Planning Framework

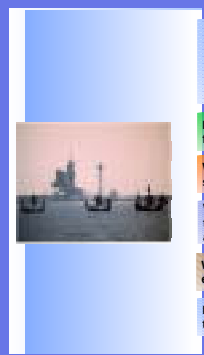
- OBPR is aligning research with the agency strategic plan and ReMAP recommendations through a ten year plan and a strategic planning process
- Ten Year Plan Complete
- Strategic planning process seeks to engage scientific community

NASA Strategic Plan
NASA Space Architect



Ten Year Plan

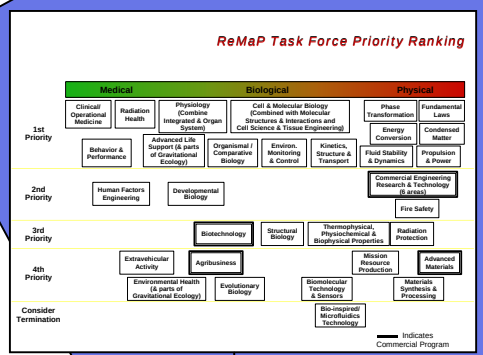
The Organizing Questions ...The OBPR Mission



Humans will extend the exploration of space. To prepare for and hasten the journey, OBPR must answer these questions through its research, principally on the ISS:

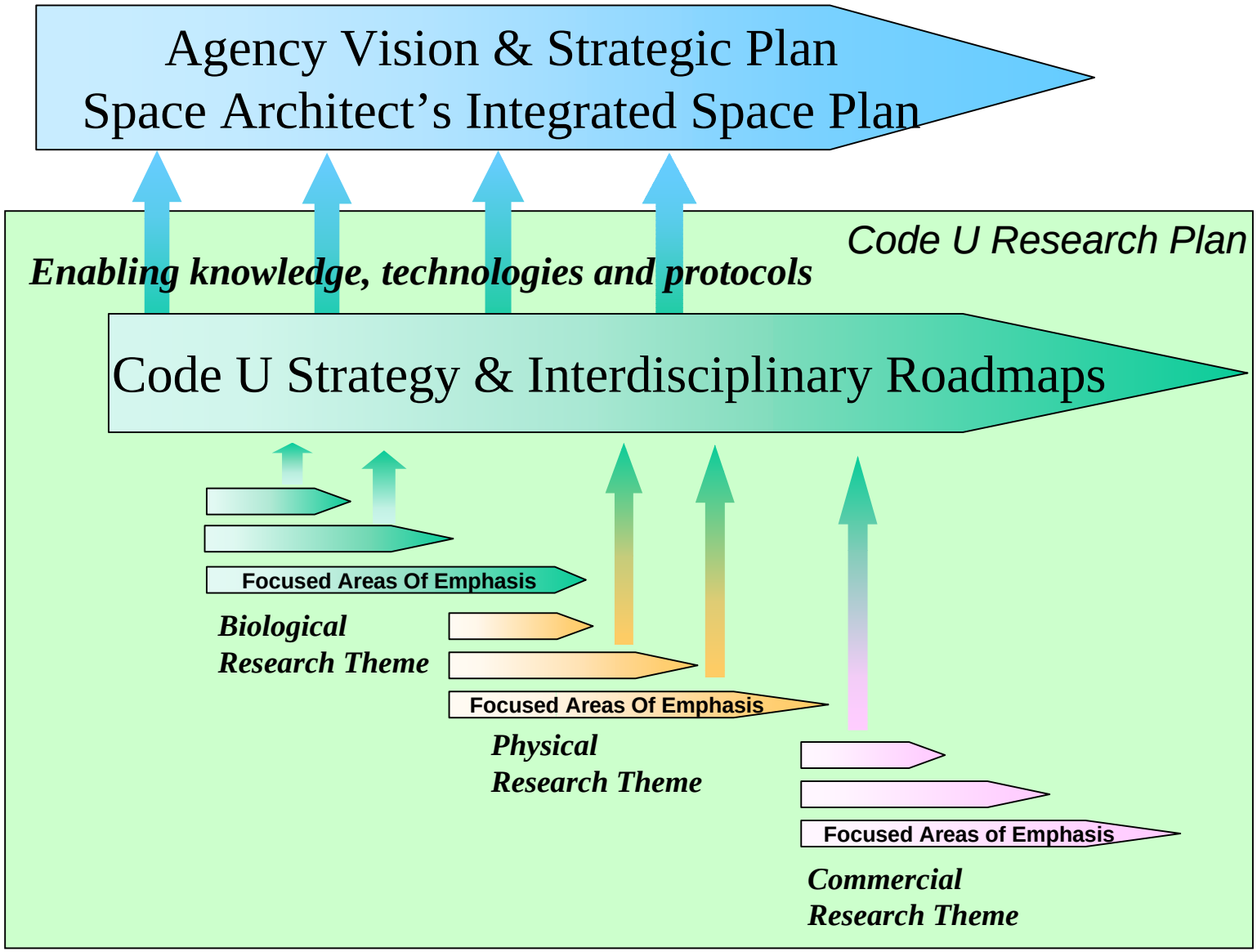
- How can we assure the survival of humans traveling far from earth?
- What must we know about how space changes life forms, so that humankind will flourish?
- What new opportunities can our research bring to expand our understanding of the laws of nature and enrich lives on Earth?
- What technology must we create to enable the next explorers to go beyond where we have been?
- How can we educate and inspire the next generations to take the journey?

ReMAP



Now **10 Years** **25 years**

OBPR Strategic Planning



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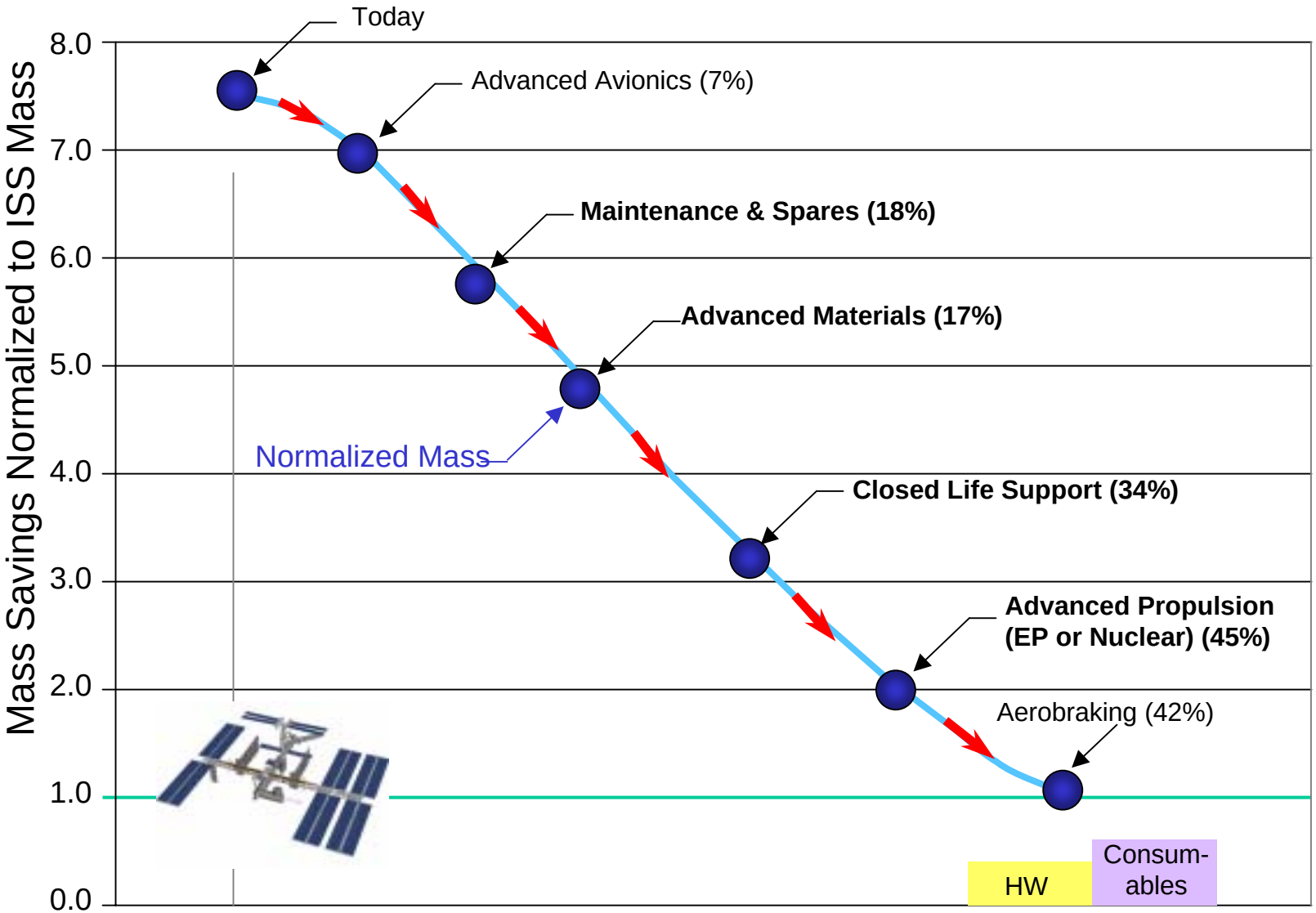
Evaluating Technology Investments
Example: Mars Human Mission



The Organizing Questions ...The OBPR Mission

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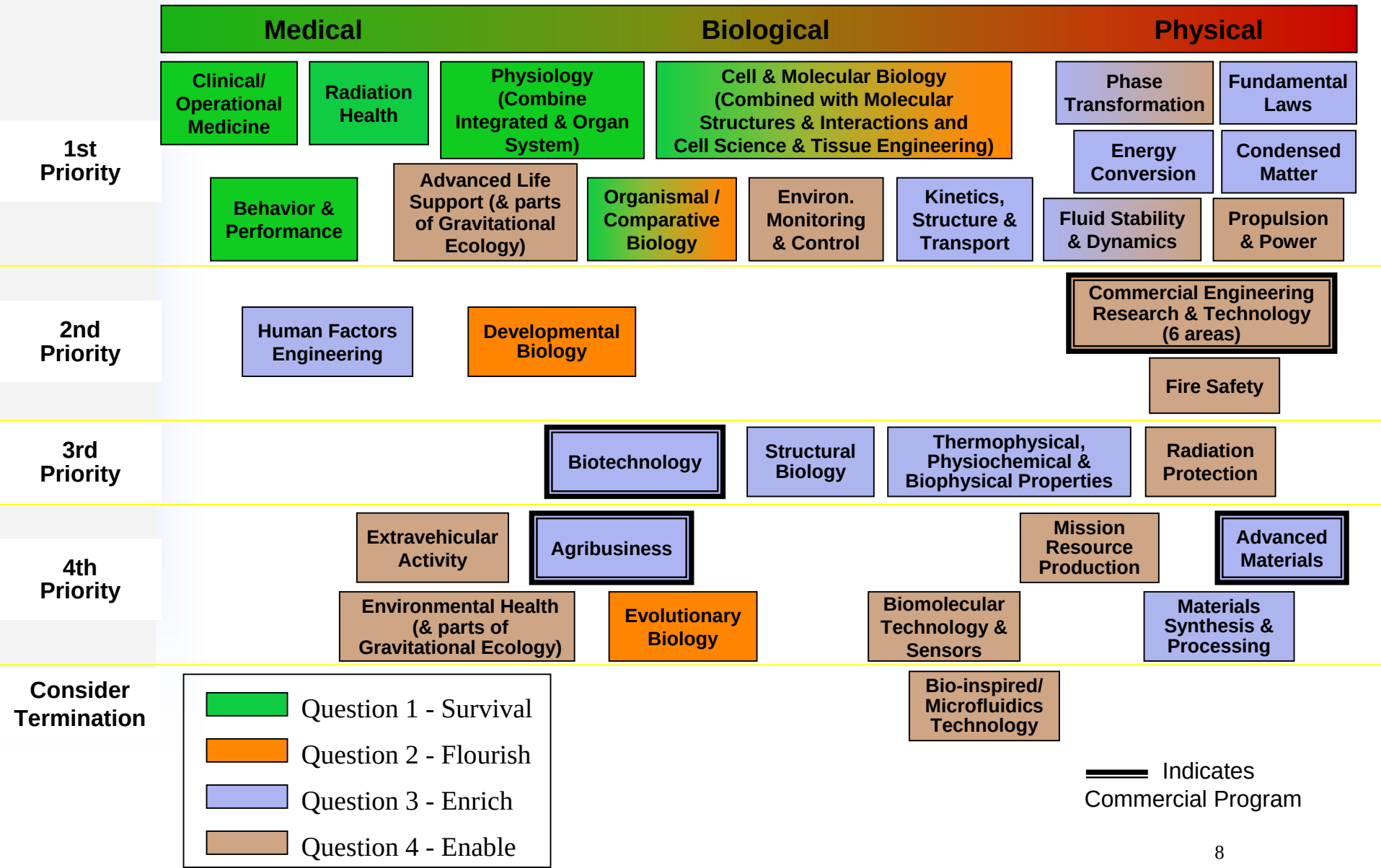
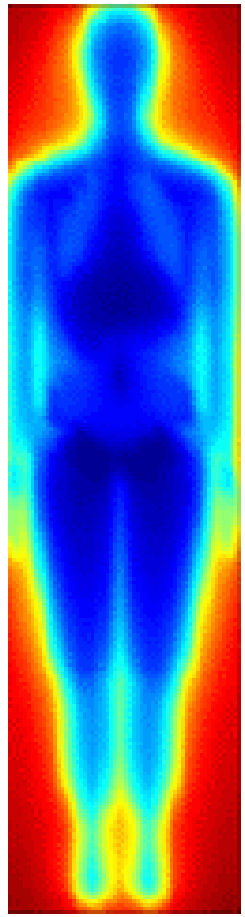
Mapping of REMAP Priorities to Overarching Questions



Human Research Initiative:
Enabling Longer Duration Human Spaceflight

- **For future missions beyond low Earth orbit**
  - Improved therapies to prevent bone and muscle loss in space
  - New technology for quickly and accurately monitoring crew health
  - Improved performance and reliability of microgravity systems for power, propulsion, and environmental control
  - Reduce, by a factor of three, the time to conduct critical research to certify crew safety for missions beyond low Earth orbit over 100 days
  - Results from space will have applications for improved health care on Earth



For efficiency of life support in space

- Enables knowledge and technology to reduce mass to orbit and beyond for life support by a factor of 3 by 2010
- Improve fire prevention, detection and suppression in space
- Research can be translated into methods for monitoring and identification of biological and chemical agents

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- Innovative In-space Fabrication
  - On-site fabrication and repair via rapid prototyping,
  - New in-space repair techniques,
  - Laser-based fabrication, and manufacturing in free space.
  - Reduces the mass and number of spares required at launch.
- Five year products include:
  - Determination of limiting physical properties of prototyped materials and of joined materials.
  - Analysis of the materials properties of components fabricated in microgravity (polymer, metallic, and ceramic parts).
  - Investigation of subtractive (cutting and ablation) and additive (melting) methods for manufacturing structures and parts from space resources.
- The eventual outcome will identify the most promising equipment and usage protocols for this breakthrough technology approach that is to reduce the requirement for spares.

Figure 4b: *What new low-gravity engineering systems and advanced materials are required to enable efficient and safe deep space travel and survival at destination?*

Scientific and technical low-gravity research and development resulting in proof-of-concept experiments providing humans in space with an energy rich, resource rich, self sustaining infrastructure at the earliest possible time and with minimum risk, launch mass, and program cost.

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KEY OBJECTIVES/ TARGETS	Today	2003 - 2008	2009 - 2016
Low-Gravity Fluid and Thermal Systems	High mass/cost, low performance. Incomplete understanding of low-gravity issues	Develop ISS experiment in two-phase flow (boiler and radiator) and fluid handling devices (propellant). Model development and validation with ground-based and ISS research	ISS proof-of-concept experiment of small-scale fully functioning power system with working fluids
Space Radiation Modeling and Shielding Materials Research	Incomplete knowledge of high-energy particle Interactions with materials. High Mass and inadequate shielding strategy.	Complete reference data collection and develop model for particle-materials interaction. Develop engineering assessment tool for radiation shielding	Complete development of advanced shielding materials. Selected radiation survey of Mars with OSS.
In-Space Fabrication and Repair	Limited materials, knowledge, single point of failure missions	Demonstration of prototype manufacturing & repair on ISS	Extension of technology using base elements or *in situ* resource materials
In situ Resource Utilization	Limited research with simulators and prototype processes for some systems	Develop partial gravity experiments for fluidized bed reactor and liquid-gas separator for oxygen production studies.	Flight and planetary surface system validation missions such as Ilmenite redduction and reverse water gas shift
RESEARCH CAPABILITIES:	Ground facilities, Parabolic aircraft ISS (EXPRESS pallet), Shuttle	Ground facilities, Parabolic aircraft ISS (EXPRESS pallet), Shuttle	ISS (EXPRESS pallet), Next generation vehicles, Free flyers, Planetary Landers

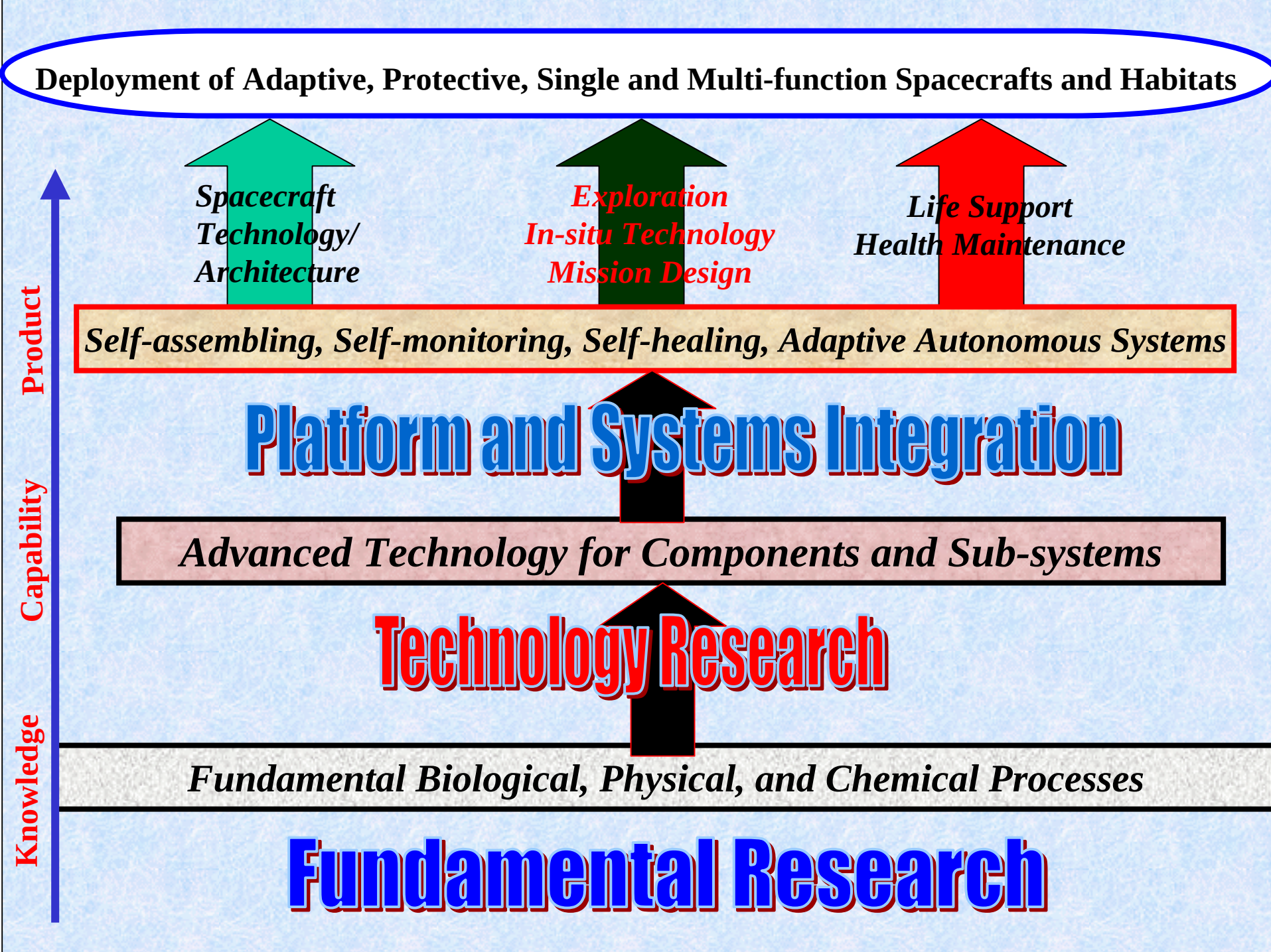
OUTCOME

Knowledge based tools, enhanced flight hardware, numerous low cost mission scenarios, and self sustaining spacecraft & human bases.

EARTH APPLICATIONS: Improved efficiency of power plants), versatile free forming technology, mineral extraction, carbon dioxide sequestration, unique material developments

Screening Criteria

- Is there an identified customer that can clearly articulate a well defined need and will be the point of contact for the research group?
- Is there a quantifiable advantage to conducting some or all of the research in space?
- Is another government agency or commercial activity already leading in investment, knowledge, and capability?
- Is another NASA Enterprise already working in the area?
  - Is the basic research aspect fully identified and supported?
- Can the Enterprise have a significant impact on the problem with the available budget?
  - If not, what budget augmentation would be needed?
- Is the identified need far enough in the future that the results of basic research can make a difference?


Deployment of Adaptive, Protective, Single and Multi-function Spacecrafts and Habitats
Spacecraft Technology/ Architecture
Exploration In-situ Technology Mission Design
Life Support Health Maintenance
Product
Capability
Knowledge
Self-assembling, Self-monitoring, Self-healing, Adaptive Autonomous Systems
Platform and Systems Integration
Advanced Technology for Components and Sub-systems
Technology Research
Fundamental Biological, Physical, and Chemical Processes
Fundamental Research